

# Enhanced Delta Smelt Monitoring

## Preliminary Abundance Analysis

### Phase 3 Sampling

**DRAFT**

U.S. Fish and Wildlife Service

October 6, 2017

## Overview

Beginning July 2017, the Enhanced Delta Smelt Monitoring (EDSM) program started its Phase 3 sampling program. The Bay-Delta has been divided into eight geographic strata:

- Western Delta
- Suisun Bay Marsh (Suisun Bay and Marsh)
- Lower Sacramento
- Cache Slough LI (Cache Slough and Liberty Island)
- Sac DW Ship Channel (Sacramento Deep Water Shipping Channel)
- Upper Sacramento
- Lower San Joaquin
- Southern Delta

Sampling locations are generated using a generalized random-tessellation stratified (GRTS) design [1] with stratification and equal probability sampling. Trawling gear similar to that used in the California Department of Fish and Wildlife's [Spring Kodiak Trawl Survey](#) is used to conduct multiple tows per location.

Everything presented here is preliminary and subject to correction, revision, and improvement. The following points should be taken into consideration when interpreting the results:

1. Delta smelt caught in the wings of the net (as opposed to the live box or cod end) were excluded from this analysis. Fish caught in the wings are indicated by a Gear Condition Code of 9.
2. The **Week** designations used here were defined out of convenience and are subject to change.
3. Current sampling is limited to areas of the Bay-Delta with a depth of at least 8 feet at mean tide. The abundance estimation method used here assumes that the density of fish in unsampled areas (i.e., those with depth less than 8 feet) is the same as in sampled areas (i.e., those with depth greater than or equal to 8 feet).
4. The methods of analysis used here remain in development.

## Change Log

Report date July 10, 2017:

- No changes.

Report date July 14, 2017:

- Sample volume corrections were made for tows in Suisun Bay Marsh during Week 1. This resulted in an increase in the abundance estimate for that week.

Report date July 21, 2017:

- Total sample volume has been added to Table 1. Sample volumes are subject to correction.
- In some strata, a single tow was conducted at one of the sites in contrast to the standard two tow minimum. This change in procedure necessitates changes to the statistical model. While these changes are in development, simple stratified ratio-expanded estimates will be shown in Table 1.

Report date July 28, 2017:

- No changes since last report.

Report date August 4, 2017:

- Sampling in the Southern Delta has been temporarily suspended as catches are expected to be low based on historic data and conditions are expected to be inhospitable. During this time, the number of sampling sites in other strata may increase as resources allow.

Report date August 11, 2017:

- Sampling for the week of August 7<sup>th</sup> occurred between Monday and Friday. This report includes data collected between Monday and Thursday; the remaining data will be included in the next report.

Report date August 18, 2017:

- Samples collected in Suisun Bay Marsh on Friday August 11<sup>th</sup> (Week 6) that were not included in the last report are now included, and the estimates for Week 6 have been recalculated. A correction has been made to Week 5 to account for the fact that one site in Suisun Bay Marsh had a single tow due to weather.

Report date August 25, 2017:

- No changes since last report.

Report date September 1, 2017:

- No changes since last report.

Report date September 8, 2017:

- Sampling for the week of September 4<sup>th</sup> occurred between Tuesday and Friday. This report includes data collected between Tuesday and Thursday; the remaining data will be included in the next report.

Report date September 15, 2017:

- Data collected on Friday September 8<sup>th</sup> have been incorporated into this report. Sampling in the Southern Delta will resume starting the week of September 18<sup>th</sup>.

Report date September 22, 2017:

- Sampling for the week of September 22<sup>nd</sup> occurred on Monday, Tuesday, Wednesday, and Friday. This report includes data collected on Monday, Tuesday, and Wednesday; the remaining data will be included in the next report. A correction was made to the total sample volume from Week 3.

Report date September 29, 2017:

- Data collected on Friday September 22<sup>nd</sup> have been incorporated into this report. Sampling for the week starting September 25<sup>th</sup> occurred on Monday, Tuesday, Wednesday, and Friday. This report includes data collected on Monday, Tuesday, and Wednesday; the remaining data will be included in the next report.

Report date October 6, 2017:

- Data collected on Friday September 29<sup>th</sup> have been incorporated into this report. Previous reports used estimates of strata volume extending to the estuary bottom. For consistency with sub-adult/adult abundance estimation analyses outside of EDSM, the volumes in this report have been changed to estimates of strata volume extending to a depth of 4 m. This has resulted in the abundance estimates being reduced.

## Results

Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. Values in blue use a stratified ratio-expanded estimation method that does not account for EDSM's stopping rules.

	Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
						Abundance	Lower Bound	Upper Bound
Week 1: July 3 - 7, 2017								
	Western Delta	4	32	0	130,560	0*	-	-
	Suisun Bay Marsh	2	5	5	12,373	140,457	55,502	296,164
	Lower Sacramento	2	10	0	21,249	0*	-	-
	Cache Slough LI	2	3	37	6,047	418,306	62,691	1,463,215
	Sac DW Ship Channel	2	4	9	4,462	49,637	24,832	89,205
	Upper Sacramento	2	13	0	44,296	0*	-	-
	Lower San Joaquin	4	20	1	32,098	6,543	698	26,114
	Southern Delta	6	48	0	179,539	0*	-	-
	Total	24	135	52	430,624	614,944	158,954	1,662,171
Week 2: July 10 - 14, 2017								
	Western Delta	2	12	0	62,818	0*	-	-
	Suisun Bay Marsh	0	-	-	-	-	-	-
	Lower Sacramento	2	10	0	20,226	0*	-	-
	Cache Slough LI	2	7	25	10,323	396,817	86,148	1,172,834
	Sac DW Ship Channel	2	7	7	10,194	37,900	8,471	110,417
	Upper Sacramento	2	16	0	57,880	0*	-	-
	Lower San Joaquin	4	20	0	37,240	0*	-	-
	Southern Delta	6	48	0	191,973	0*	-	-
	Total	20	120	32	390,654	-	-	-
Week 3: July 17 - 20, 2017								
	Western Delta	4	32	0	120,388	0*	-	-
	Suisun Bay Marsh	2	7	10	13,558	422,161	87,309	1,277,610
	Lower Sacramento	2	10	0	16,169	0*	-	-
	Cache Slough LI	2	4	27	5,117	360,756	45,363	1,354,263
	Sac DW Ship Channel	2	6	40	8,721	112,926	13,984	426,429
	Upper Sacramento	2	16	0	53,937	0*	-	-
	Lower San Joaquin	4	20	0	40,021	0*	-	-
	Southern Delta	6	48	0	199,987	0*	-	-
	Total	24	143	77	457,897	895,843	271,688	2,217,295
Week 4: July 24 - 27, 2017								
	Western Delta	4	26	2	116,912	36,030	6,089	119,693
	Suisun Bay Marsh	2	10	2	18,635	37,340	3,573	154,831
	Lower Sacramento	2	11	0	23,195	0*	-	-
	Cache Slough LI	2	10	0	18,250	0*	-	-
	Sac DW Ship Channel	2	2	62	2,660	573,986	395,952	805,229
	Upper Sacramento	2	16	0	62,159	0*	-	-
	Lower San Joaquin	4	20	0	49,623	0*	-	-

Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. Values in blue use a stratified ratio-expanded estimation method that does not account for EDSM's stopping rules.

Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
					Abundance	Lower Bound	Upper Bound
Southern Delta	6	49	0	201,306	0*	-	-
Total	24	144	66	492,739	647,357	445,671	909,671
<b>Week 5: July 31 - August 3, 2017</b>							
Western Delta	8	52	8	265,007	45,755	12,742	118,790
Suisun Bay Marsh	5	15	4	29,564	47,075	14,531	115,343
Lower Sacramento	2	7	1	12,931	13,454	1,660	50,879
Cache Slough LI	2	10	0	15,046	0*	-	-
Sac DW Ship Channel	2	7	2	13,950	7,598	1,522	23,350
Upper Sacramento	2	16	0	52,469	0*	-	-
Lower San Joaquin	4	20	0	34,067	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	25	127	15	423,034	-	-	-
<b>Week 6: August 7 - 11, 2017</b>							
Western Delta	6	43	1	201,700	2,078	287	7,517
Suisun Bay Marsh	4	15	3	30,984	41,169	12,762	100,626
Lower Sacramento	2	10	0	19,214	0*	-	-
Cache Slough LI	2	7	1	11,903	8,862	1,539	29,087
Sac DW Ship Channel	2	10	0	15,586	0*	-	-
Upper Sacramento	2	16	0	68,334	0*	-	-
Lower San Joaquin	5	19	2	41,841	15,870	4,601	40,294
Southern Delta	0	-	-	-	-	-	-
Total	23	120	7	389,562	-	-	-
<b>Week 7: August 14 - 17, 2017</b>							
Western Delta	7	35	4	167,339	10,012	2,905	25,410
Suisun Bay Marsh	4	16	4	30,210	56,147	18,340	133,111
Lower Sacramento	2	10	0	21,592	0*	-	-
Cache Slough LI	2	10	0	16,495	0*	-	-
Sac DW Ship Channel	2	9	1	16,409	1,501	208	5,425
Upper Sacramento	2	16	0	51,845	0*	-	-
Lower San Joaquin	5	21	0	41,818	0*	NA	NA
Southern Delta	0	-	-	-	-	-	-
Total	24	117	9	345,708	-	-	-
<b>Week 8: August 21 - 24, 2017</b>							
Western Delta	8	49	3	217,979	7,603	2,943	16,244
Suisun Bay Marsh	3	9	6	21,203	172,999	61,225	390,864
Lower Sacramento	2	7	1	17,005	15,405	2,676	50,556
Cache Slough LI	2	10	0	22,146	0*	-	-
Sac DW Ship Channel	2	7	1	18,212	1,352	187	4,888
Upper Sacramento	2	16	0	70,222	0*	-	-

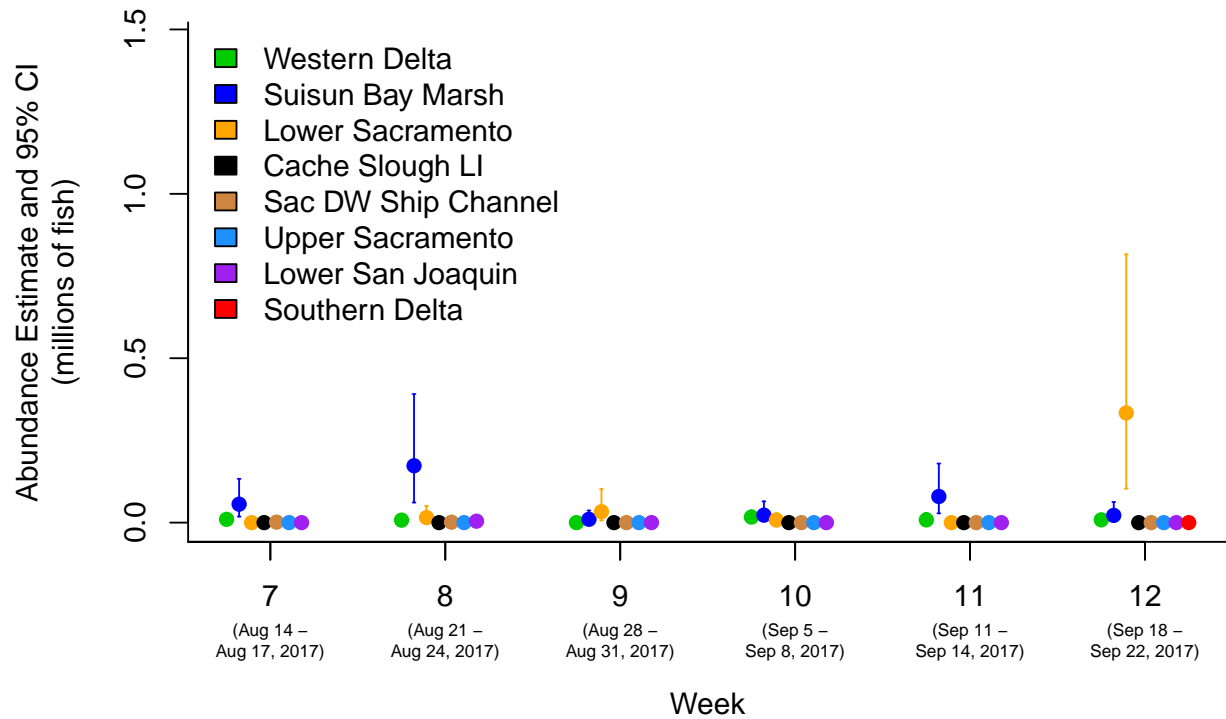
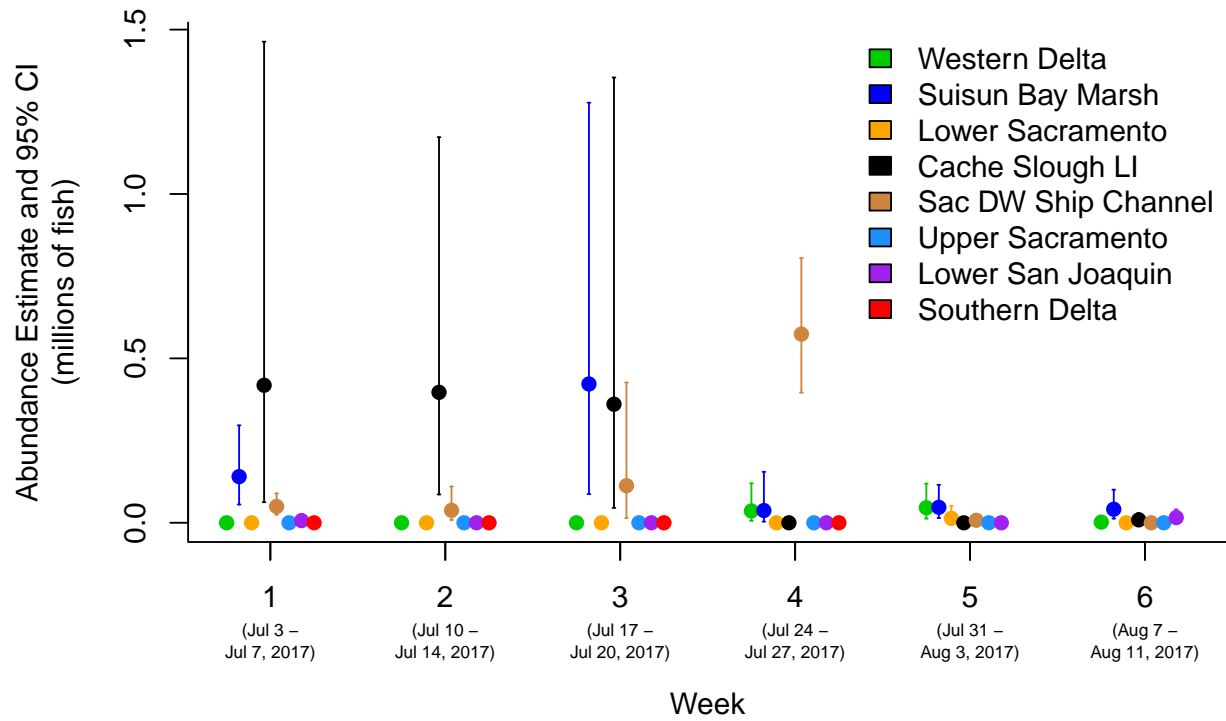
Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. Values in blue use a stratified ratio-expanded estimation method that does not account for EDSM's stopping rules.

Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
					Abundance	Lower Bound	Upper Bound
Lower San Joaquin	4	17	1	41,423	4,398	363	19,143
Southern Delta	0	-	-	-	-	-	-
Total	23	115	12	408,192	-	-	-
<b>Week 9: August 28 - 31, 2017</b>							
Western Delta	8	64	0	286,318	0*	-	-
Suisun Bay Marsh	4	17	1	34,253	10,171	1,411	36,724
Lower Sacramento	2	7	2	17,821	33,255	6,688	102,003
Cache Slough LI	2	10	0	20,386	0*	-	-
Sac DW Ship Channel	2	10	0	20,328	0*	-	-
Upper Sacramento	2	16	0	68,813	0*	-	-
Lower San Joaquin	4	20	0	38,907	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	24	144	3	486,826	-	-	-
<b>Week 10: September 5 - 8, 2017</b>							
Western Delta	8	47	6	198,935	16,916	6,315	36,976
Suisun Bay Marsh	4	17	2	30,618	22,728	5,328	64,639
Lower Sacramento	2	10	1	22,027	7,864	1,088	28,433
Cache Slough LI	2	10	0	19,644	0*	-	-
Sac DW Ship Channel	2	10	0	20,371	0*	-	-
Upper Sacramento	2	16	0	66,063	0*	-	-
Lower San Joaquin	4	20	0	33,524	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	24	130	9	391,181	-	-	-
<b>Week 11: September 11 - 14, 2017</b>							
Western Delta	8	53	4	225,500	8,343	1,208	29,599
Suisun Bay Marsh	4	9	4	17,502	79,514	28,175	179,512
Lower Sacramento	2	10	0	21,366	0*	-	-
Cache Slough LI	2	10	0	15,500	0*	-	-
Sac DW Ship Channel	2	10	0	20,525	0*	-	-
Upper Sacramento	2	16	0	50,705	0*	-	-
Lower San Joaquin	4	20	0	34,451	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	24	128	8	385,549	-	-	-
<b>Week 12: September 18 - 22, 2017</b>							
Western Delta	4	24	2	98,732	8,488	1,988	24,148
Suisun Bay Marsh	4	16	2	31,611	22,014	5,161	62,606
Lower Sacramento	2	4	17	8,906	333,709	103,414	815,802
Cache Slough LI	2	10	0	18,690	0*	-	-
Sac DW Ship Channel	2	10	0	18,869	0*	-	-

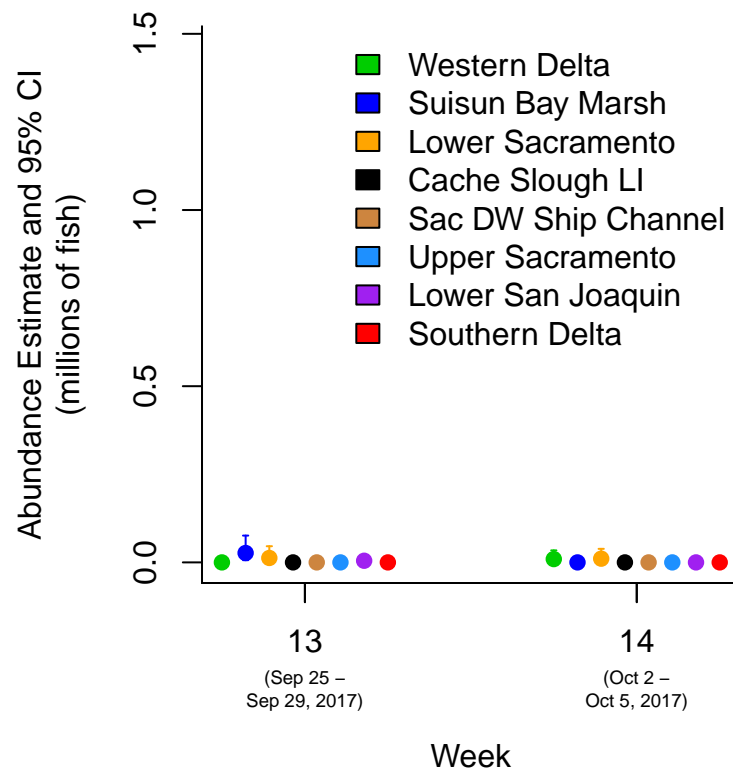
Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (\*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. Values in blue use a stratified ratio-expanded estimation method that does not account for EDSM's stopping rules.

Stratum	Number of Sites	Number of Tows	Number Caught	Total Sample Volume	Estimate and 95% CI		
					Abundance	Lower Bound	Upper Bound
Upper Sacramento	2	16	0	70,723	0*	-	-
Lower San Joaquin	4	20	0	38,803	0*	-	-
Southern Delta	4	34	0	118,099	0*	-	-
Total	24	134	21	404,433	364,211	123,786	843,295
<b>Week 13: September 25 - 29, 2017</b>							
Western Delta	4	32	0	345,773	0*	-	-
Suisun Bay Marsh	3	13	2	26,026	26,741	6,266	76,068
Lower Sacramento	2	7	1	15,525	12,575	1,701	45,866
Cache Slough LI	2	10	0	28,028	0*	-	-
Sac DW Ship Channel	2	9	0	17,247	0*	-	-
Upper Sacramento	2	16	0	61,901	0*	-	-
Lower San Joaquin	4	19	1	34,256	4,740	655	17,137
Southern Delta	4	32	0	95,339	0*	-	-
Total	23	138	4	624,095	44,055	14,720	103,053
<b>Week 14: October 2 - 5, 2017</b>							
Western Delta	3	11	1	44,477	9,417	1,302	34,051
Suisun Bay Marsh	4	20	0	41,769	0*	-	-
Lower Sacramento	2	8	1	16,299	10,629	1,471	38,422
Cache Slough LI	2	10	0	24,411	0*	-	-
Sac DW Ship Channel	2	10	0	20,737	0*	-	-
Upper Sacramento	2	16	0	52,640	0*	-	-
Lower San Joaquin	4	20	0	41,833	0*	-	-
Southern Delta	4	32	0	98,325	0*	-	-
Total	23	127	2	340,491	20,046	4,687	57,087

### Delta Smelt Abundance Estimates Over Time

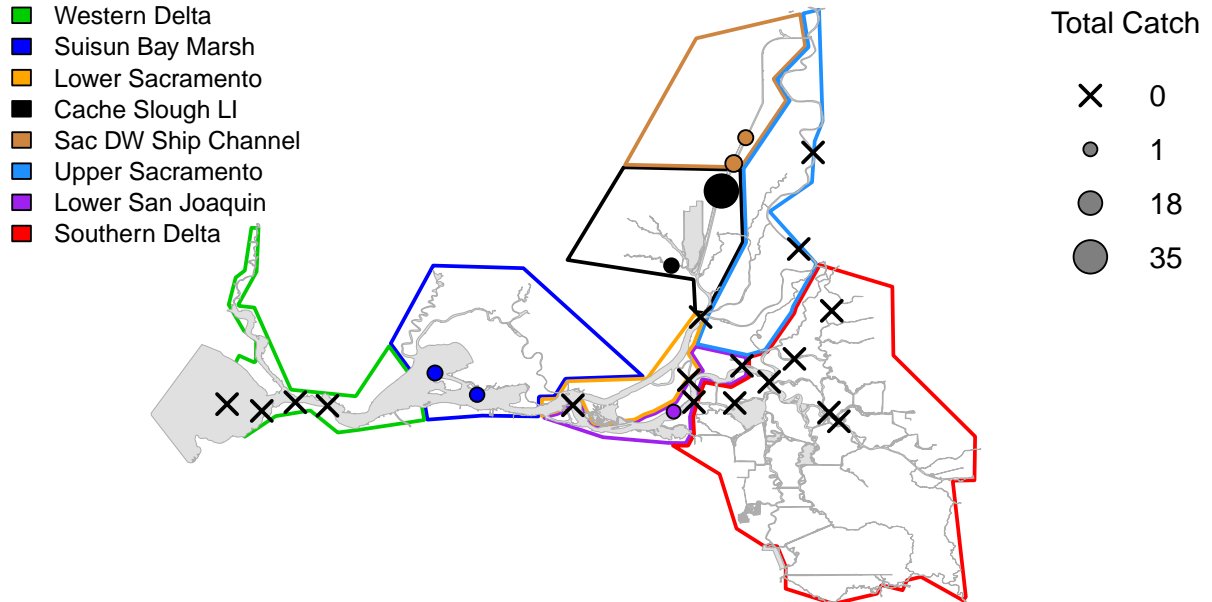




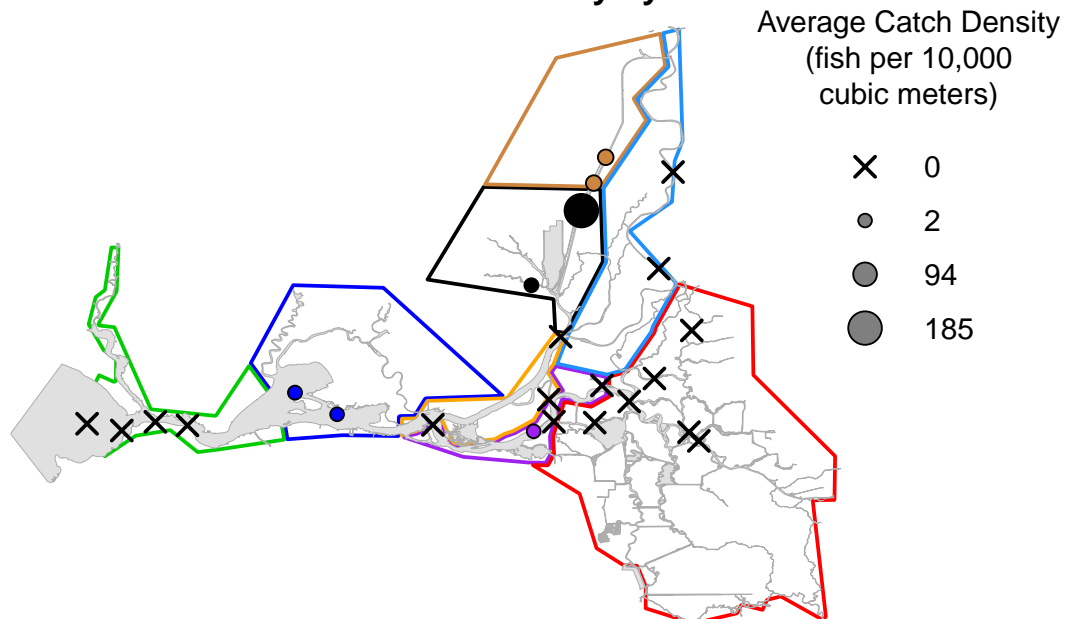


## Week 1 (Jul 3 – Jul 7, 2017)

### Delta Smelt Total Catch by Site

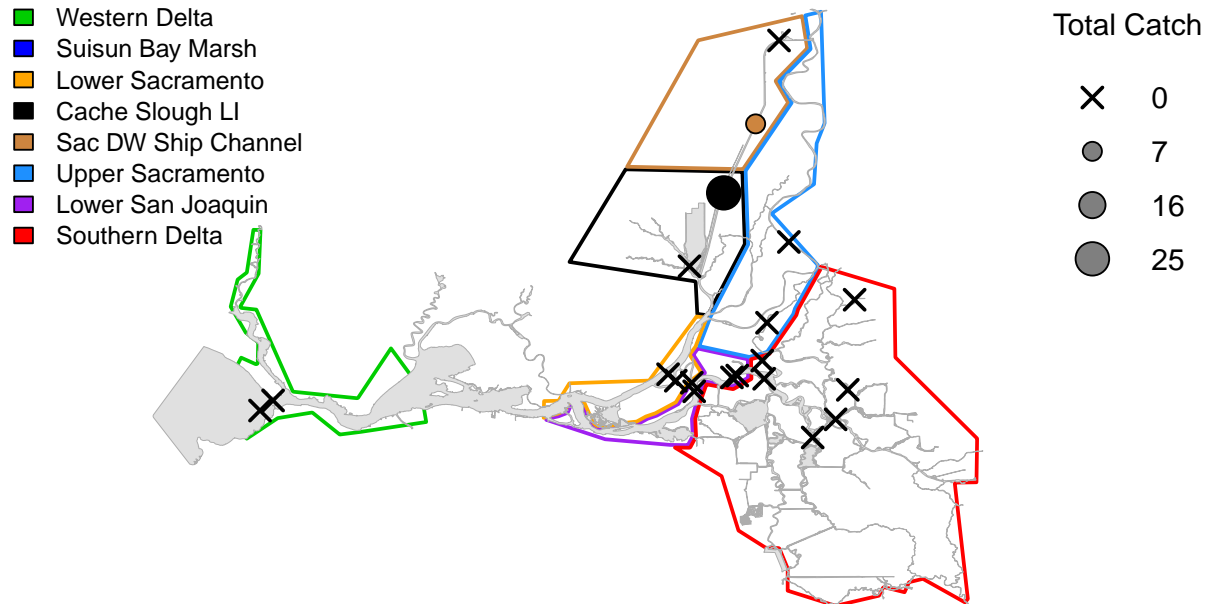


### Delta Smelt Catch Density by Site

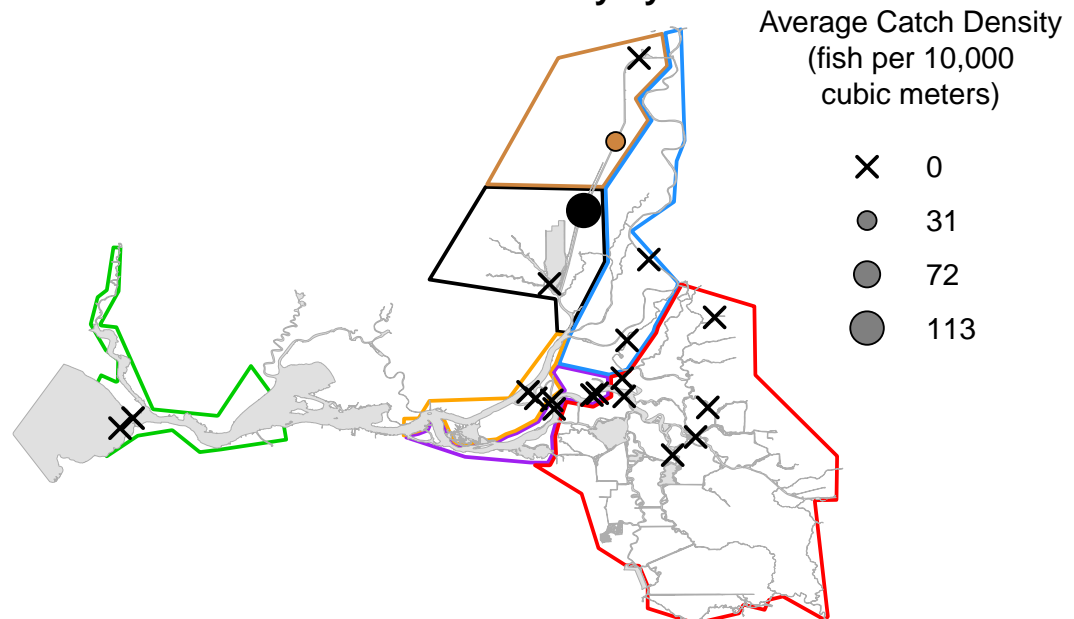


## Week 2 (Jul 10 – Jul 14, 2017)

### Delta Smelt Total Catch by Site

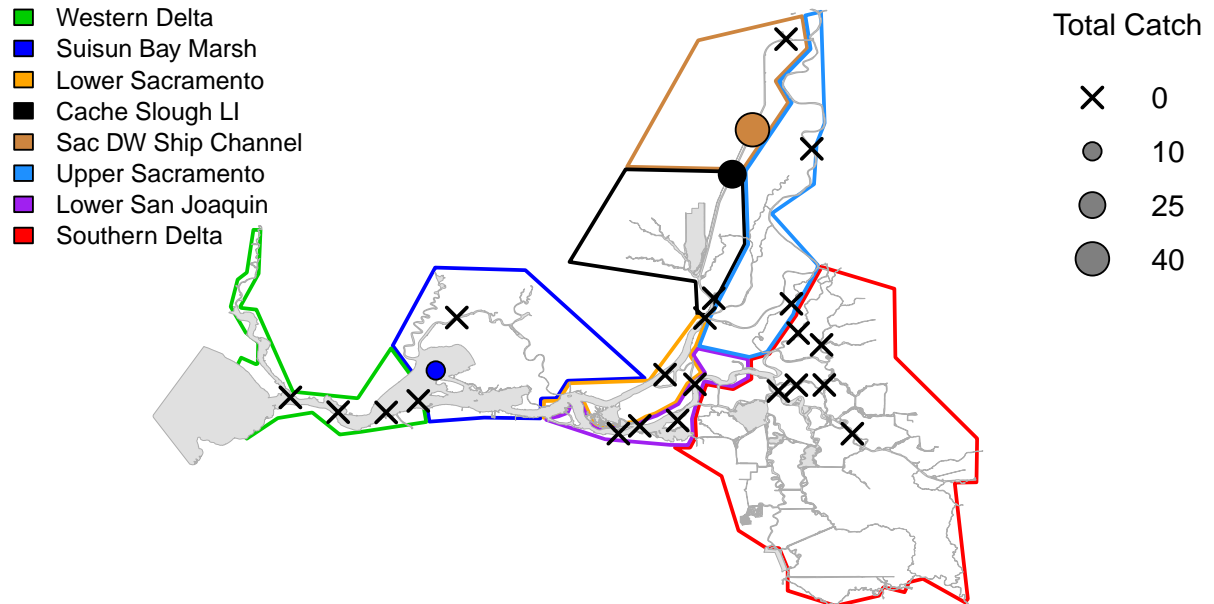


### Delta Smelt Catch Density by Site

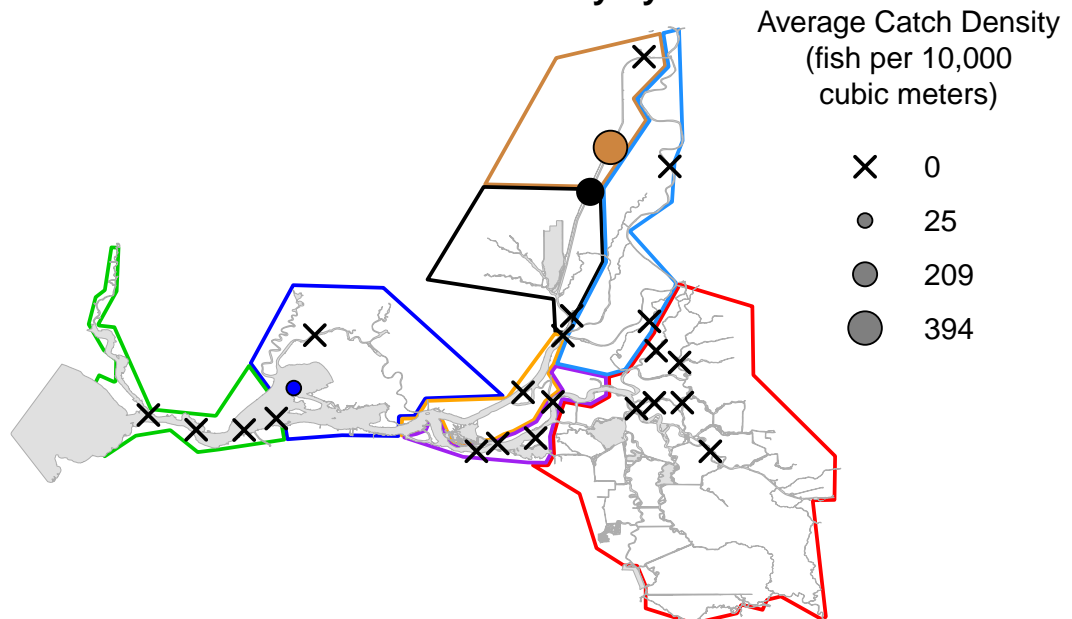


## Week 3 (Jul 17 – Jul 20, 2017)

### Delta Smelt Total Catch by Site

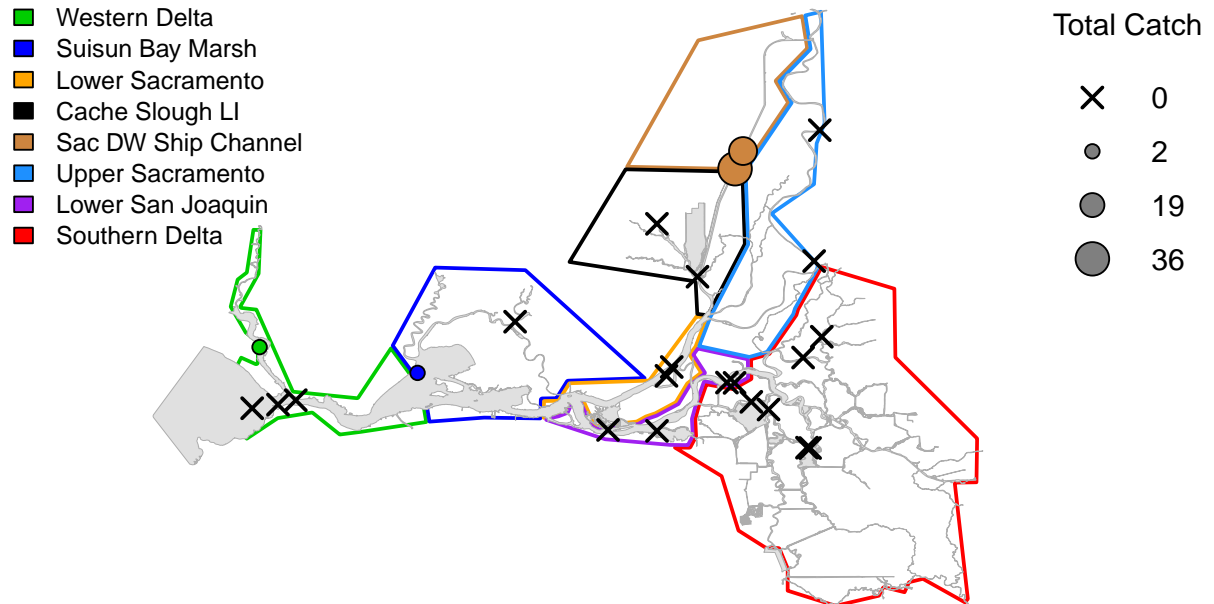


### Delta Smelt Catch Density by Site

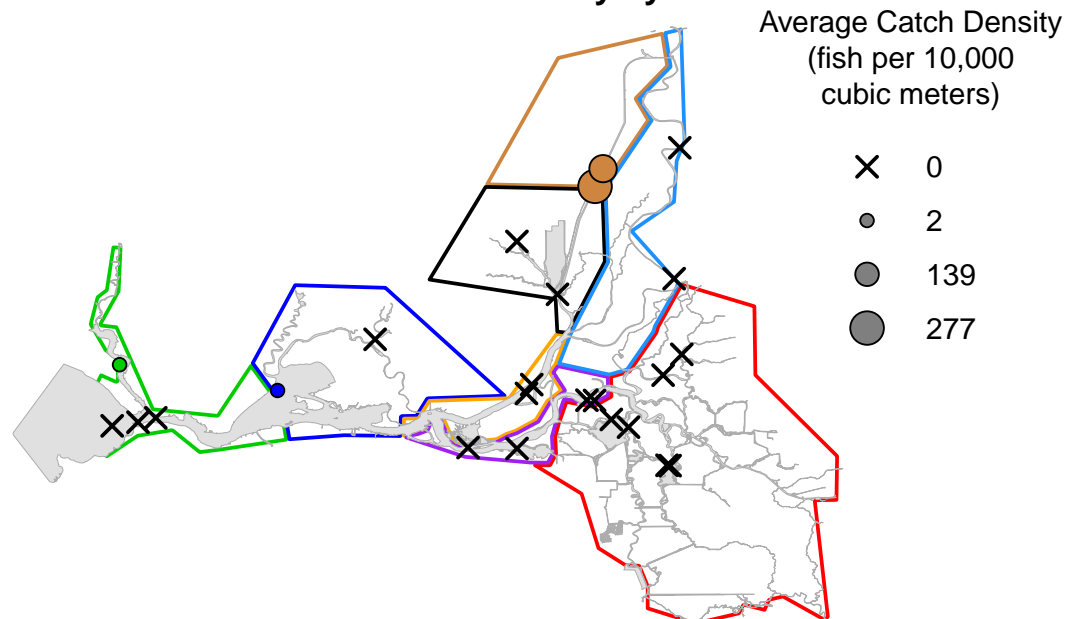


## Week 4 (Jul 24 – Jul 27, 2017)

### Delta Smelt Total Catch by Site

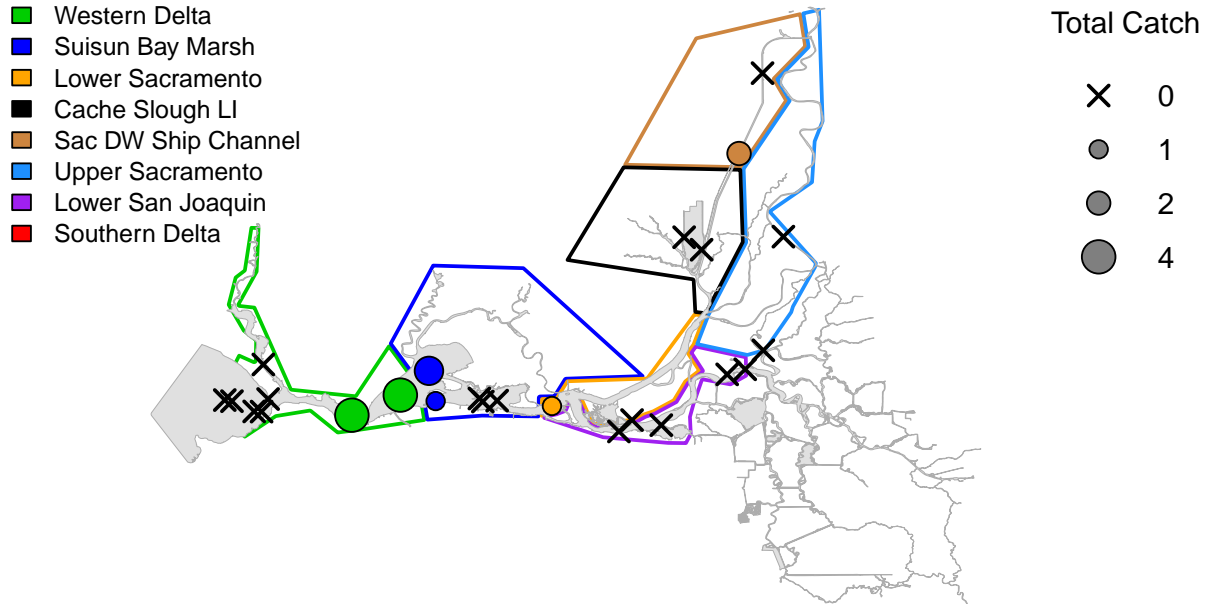


### Delta Smelt Catch Density by Site

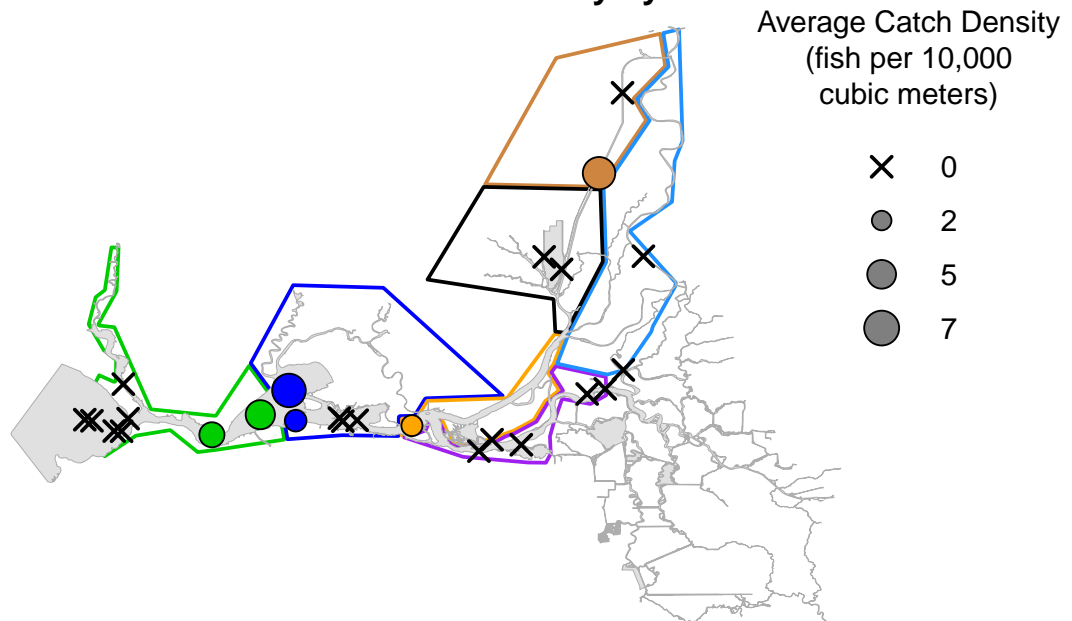


## Week 5 (Jul 31 – Aug 3, 2017)

### Delta Smelt Total Catch by Site

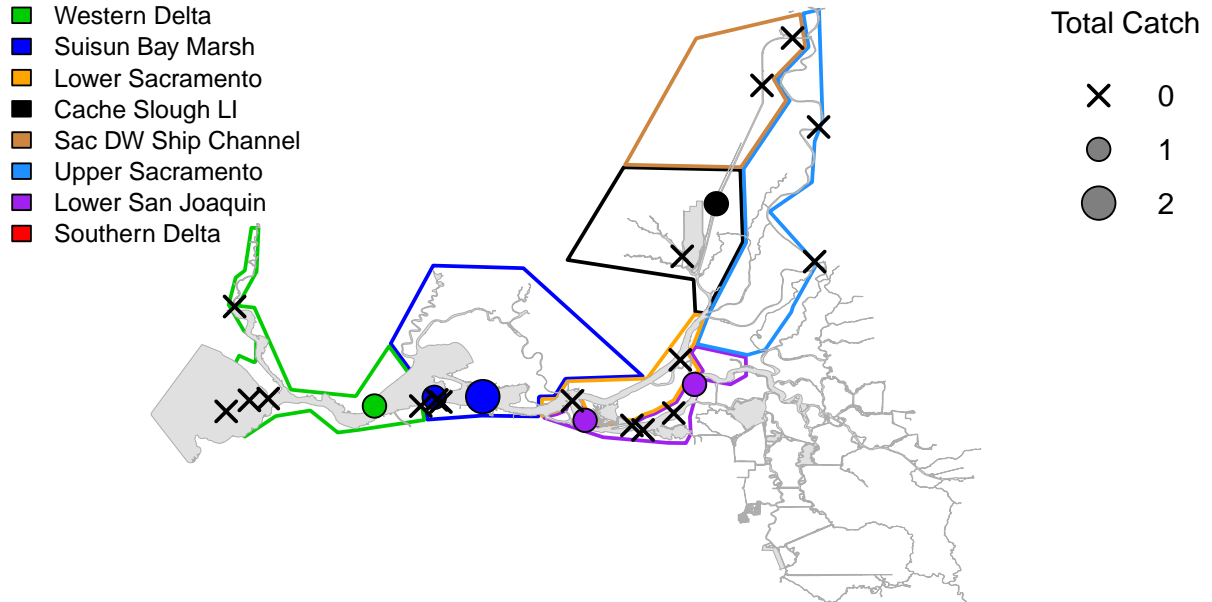


### Delta Smelt Catch Density by Site

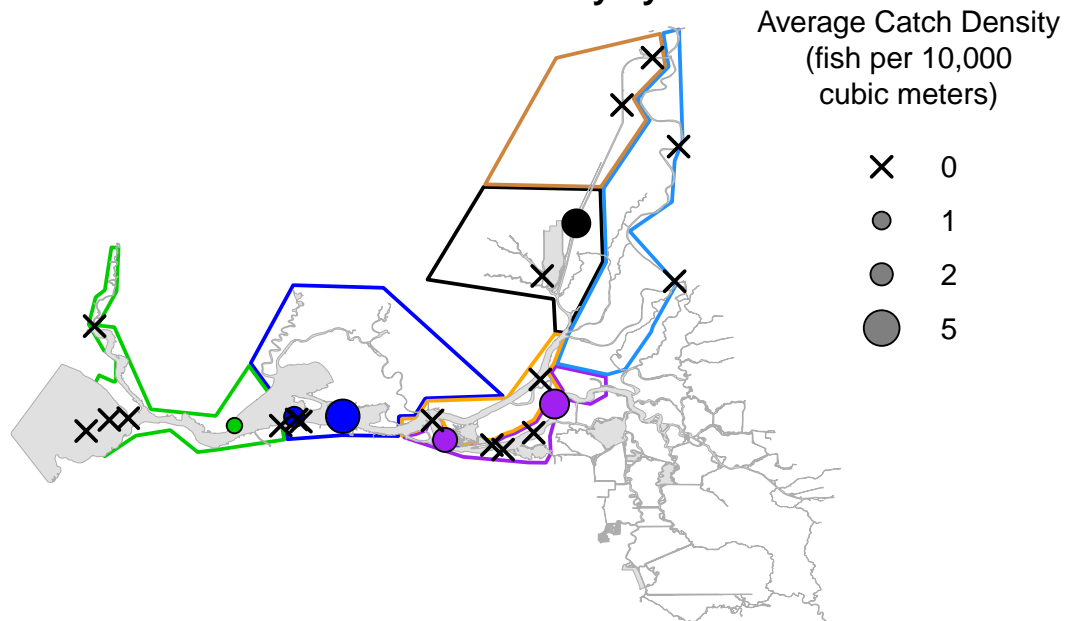


## Week 6 (Aug 7 – Aug 11, 2017)

### Delta Smelt Total Catch by Site

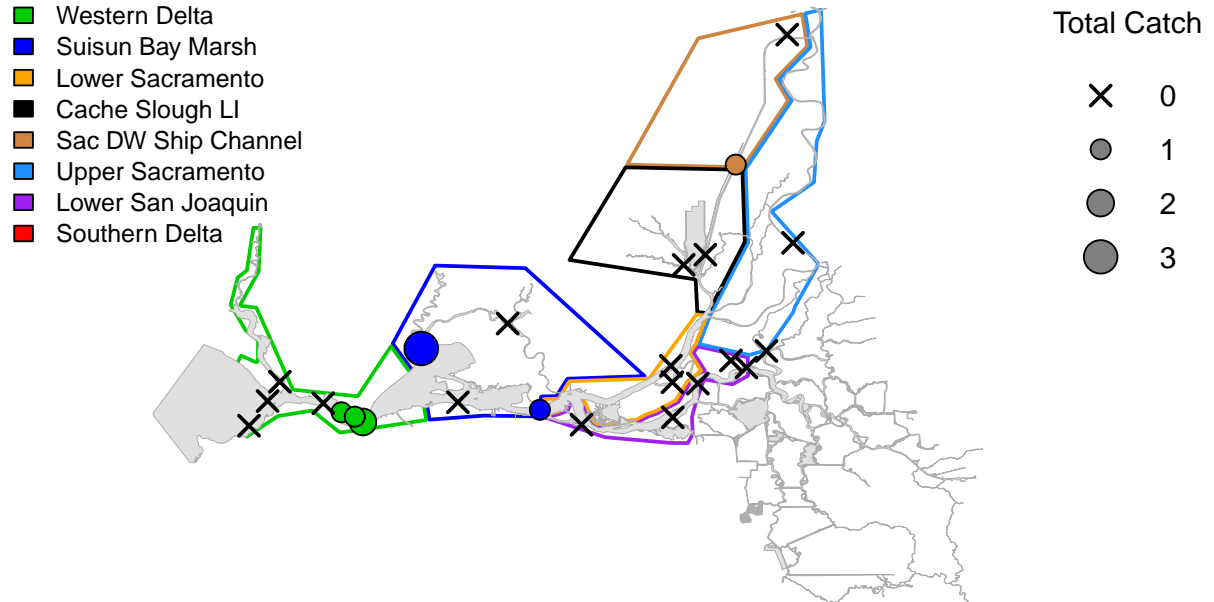


### Delta Smelt Catch Density by Site

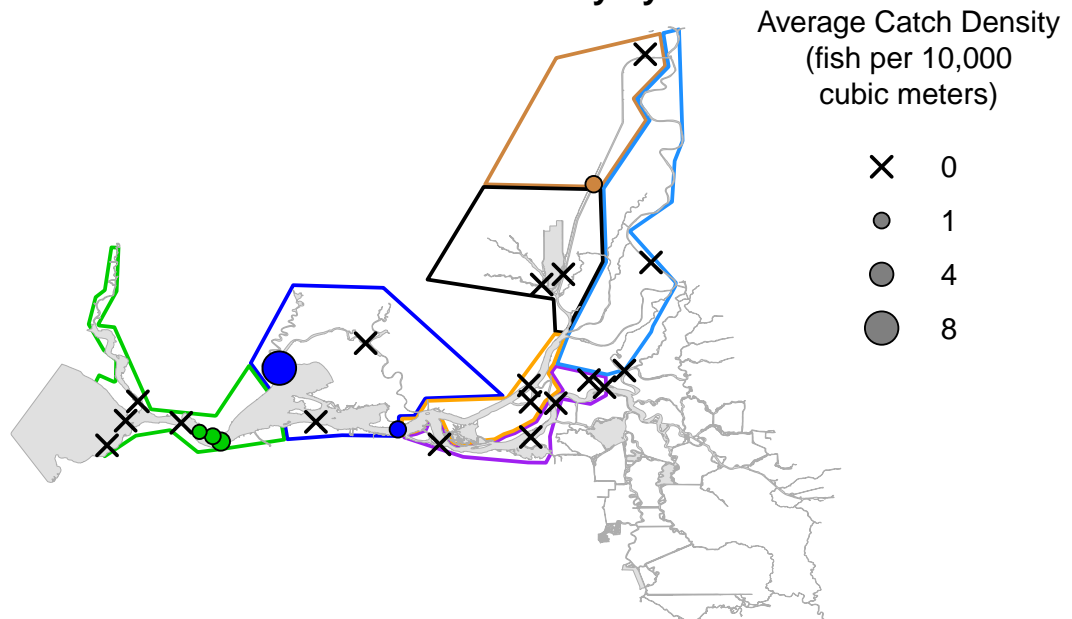


## Week 7 (Aug 14 – Aug 17, 2017)

### Delta Smelt Total Catch by Site



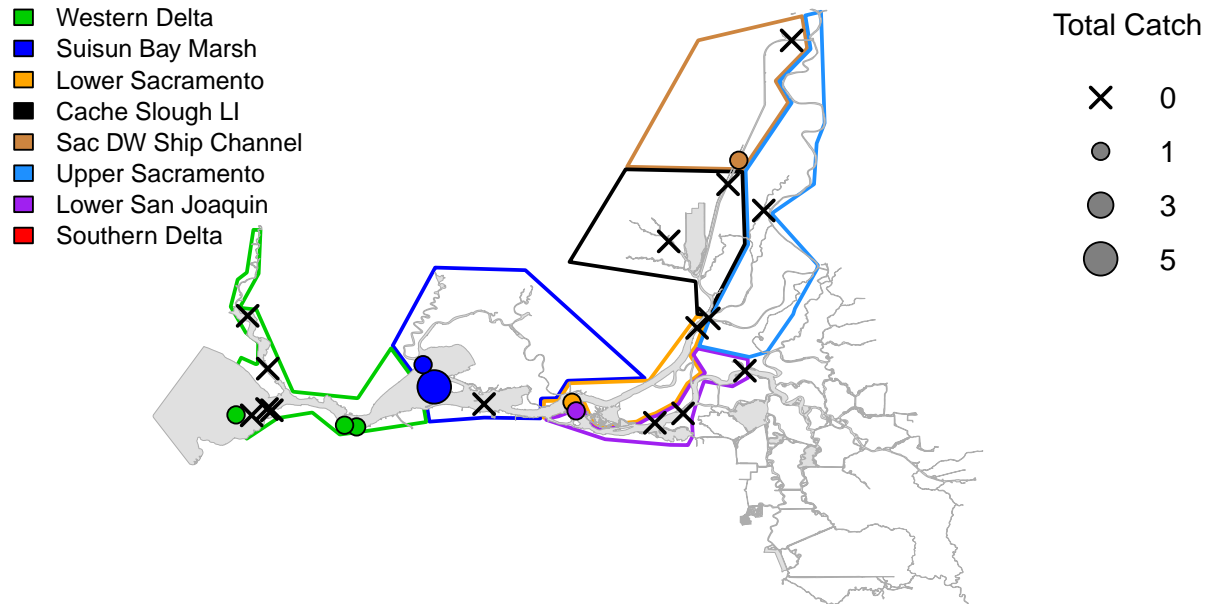
### Delta Smelt Catch Density by Site



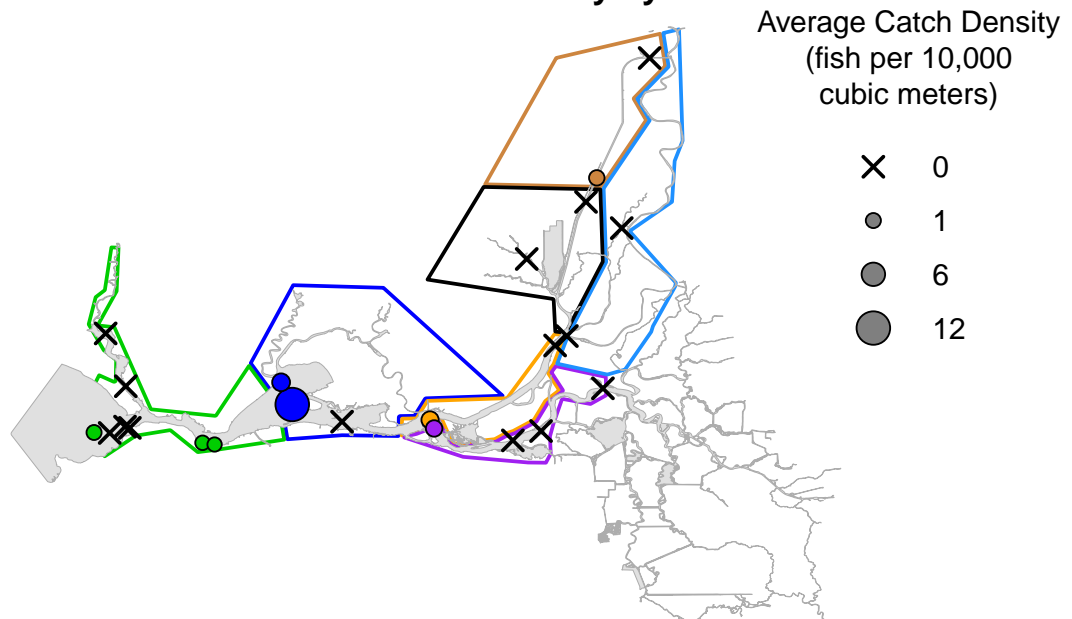


## Week 8 (Aug 21 – Aug 24, 2017)

### Delta Smelt Total Catch by Site

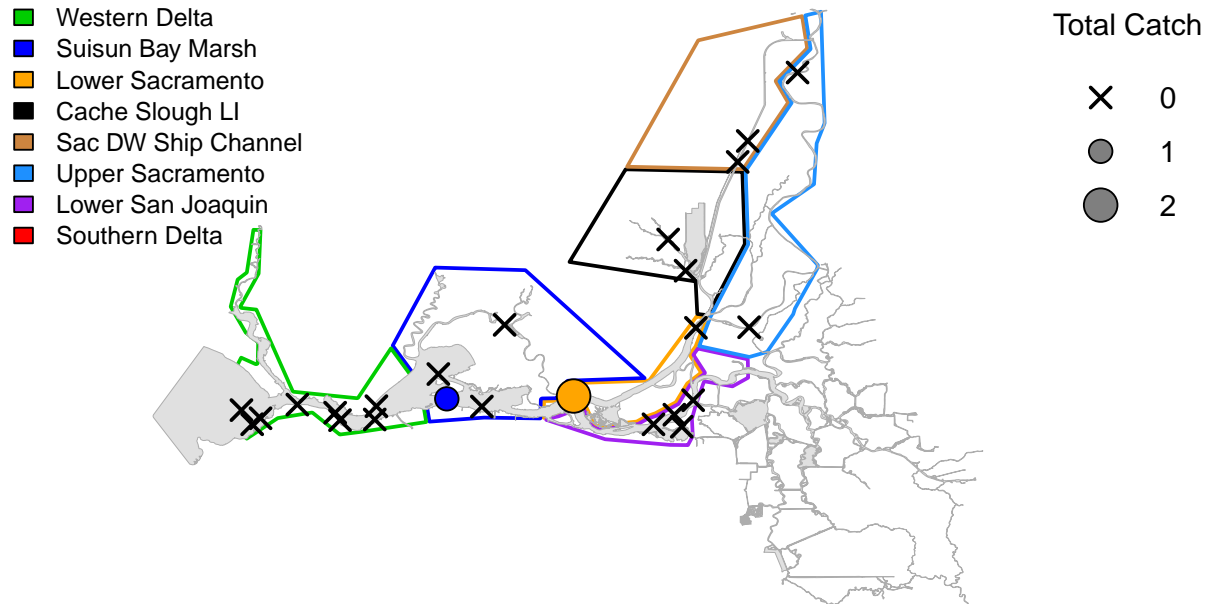


### Delta Smelt Catch Density by Site

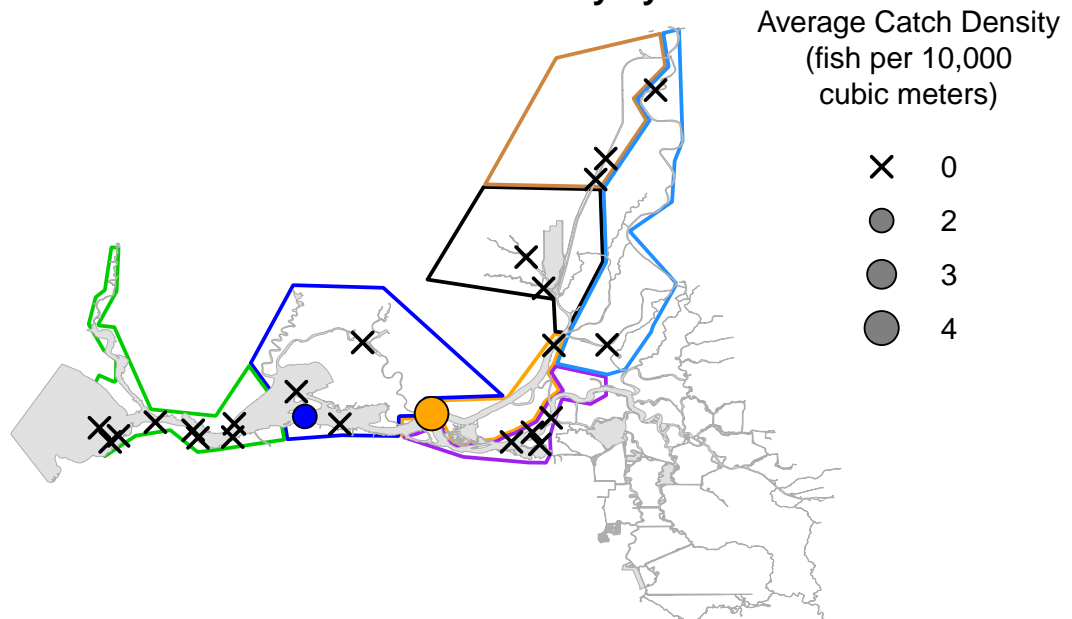


## Week 9 (Aug 28 – Aug 31, 2017)

### Delta Smelt Total Catch by Site

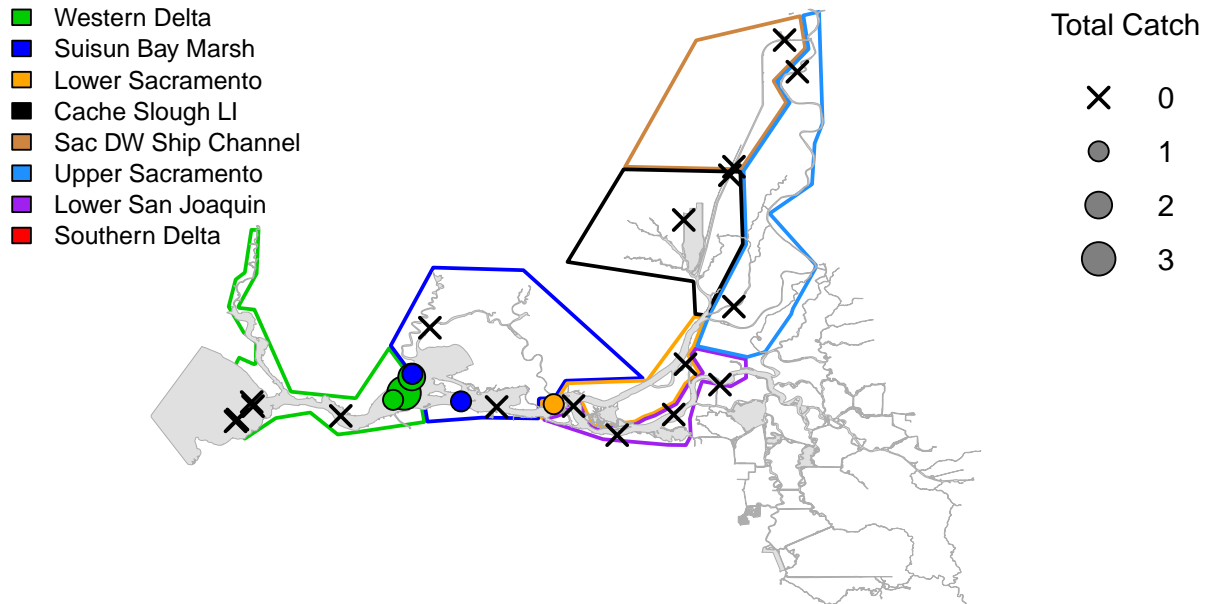


### Delta Smelt Catch Density by Site

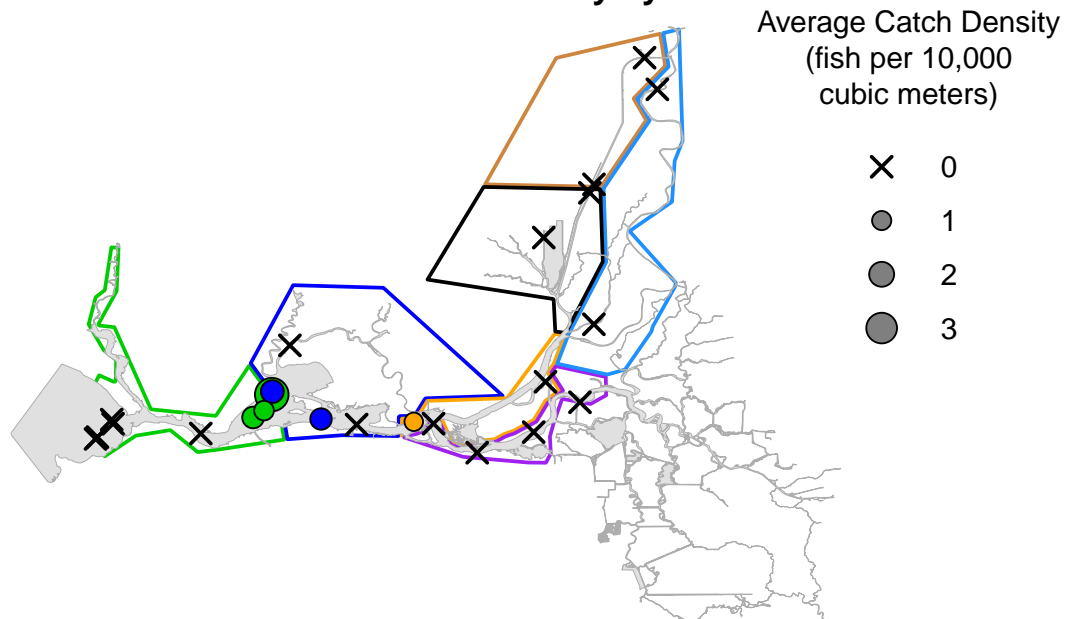


## Week 10 (Sep 5 – Sep 8, 2017)

### Delta Smelt Total Catch by Site

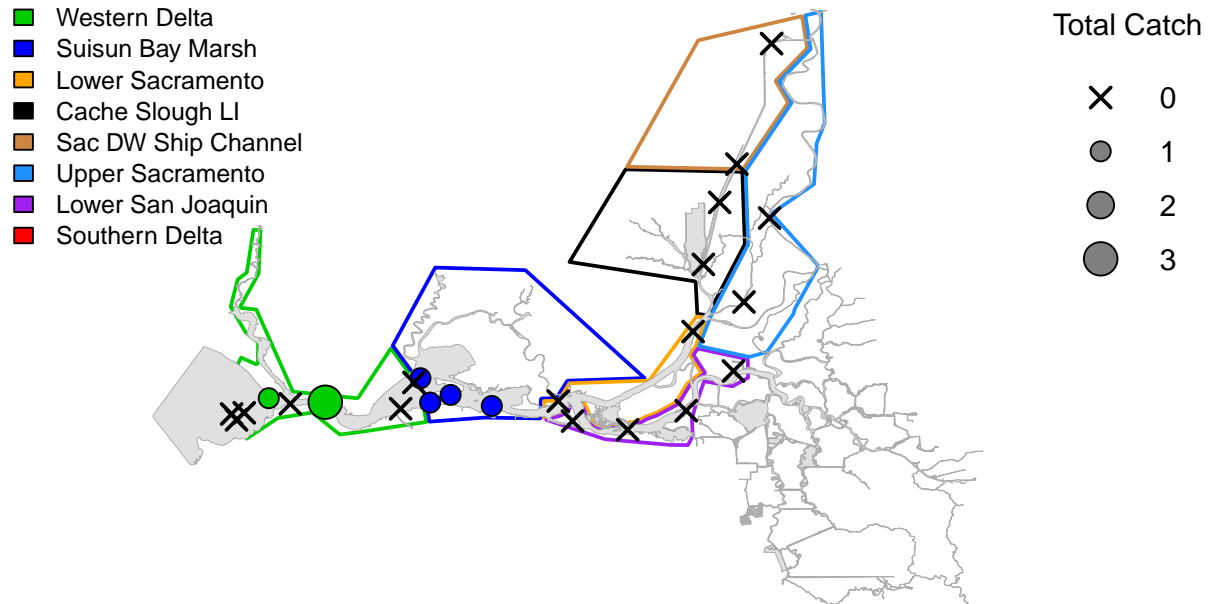


### Delta Smelt Catch Density by Site

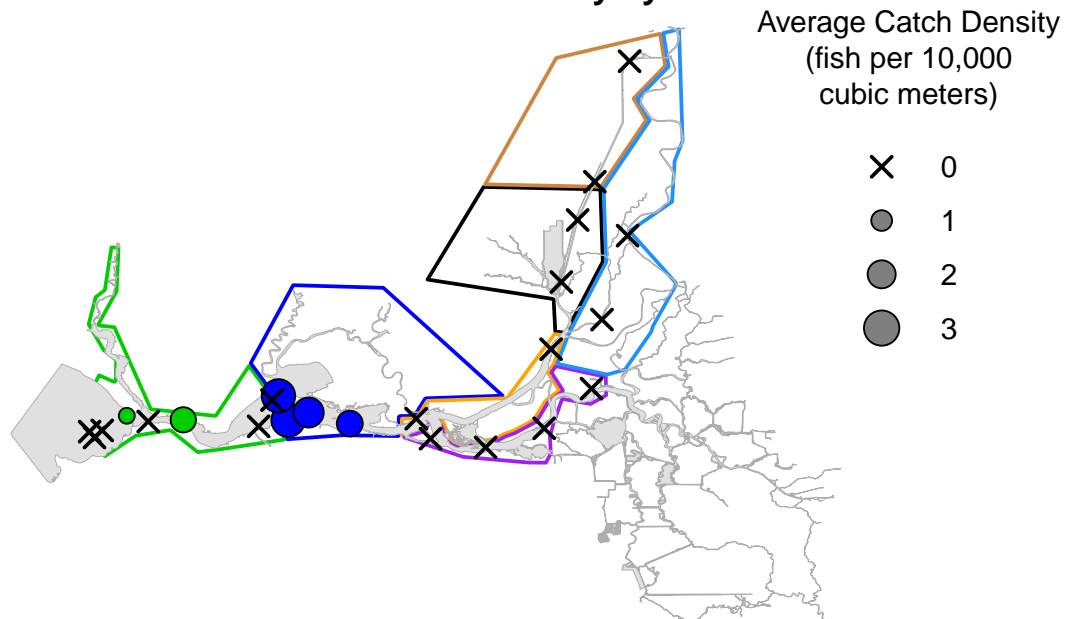


## Week 11 (Sep 11 – Sep 14, 2017)

### Delta Smelt Total Catch by Site

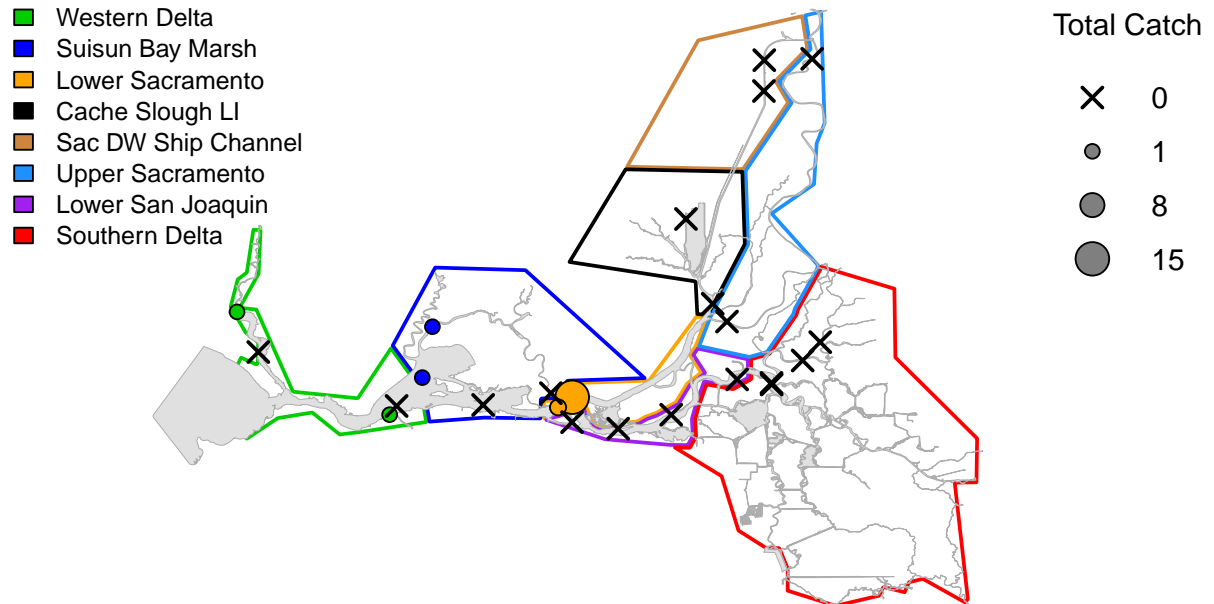


### Delta Smelt Catch Density by Site

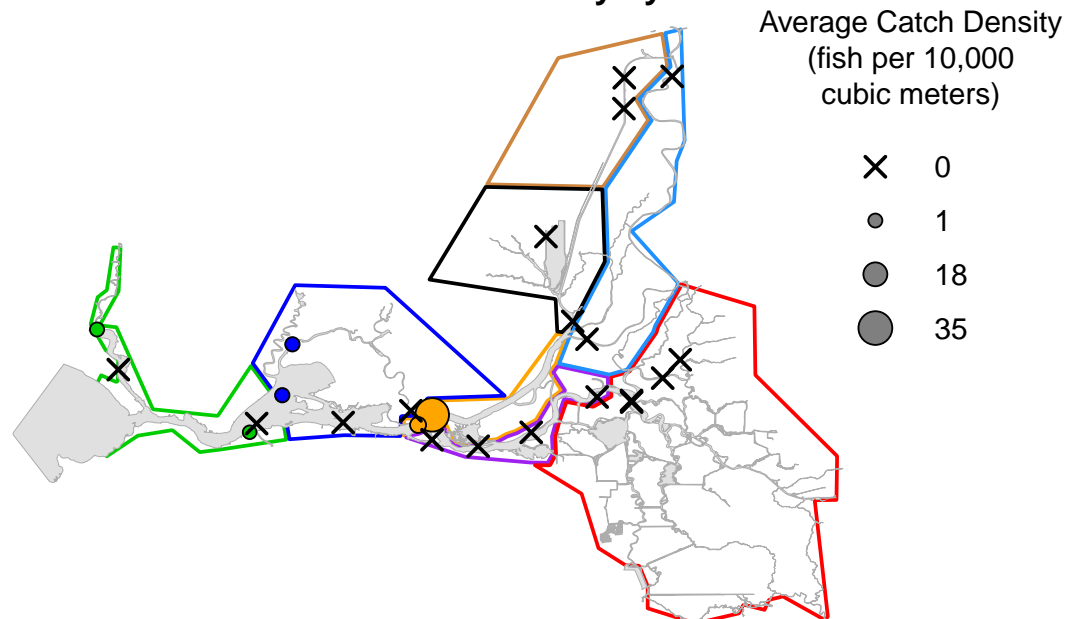


## Week 12 (Sep 18 – Sep 22, 2017)

### Delta Smelt Total Catch by Site

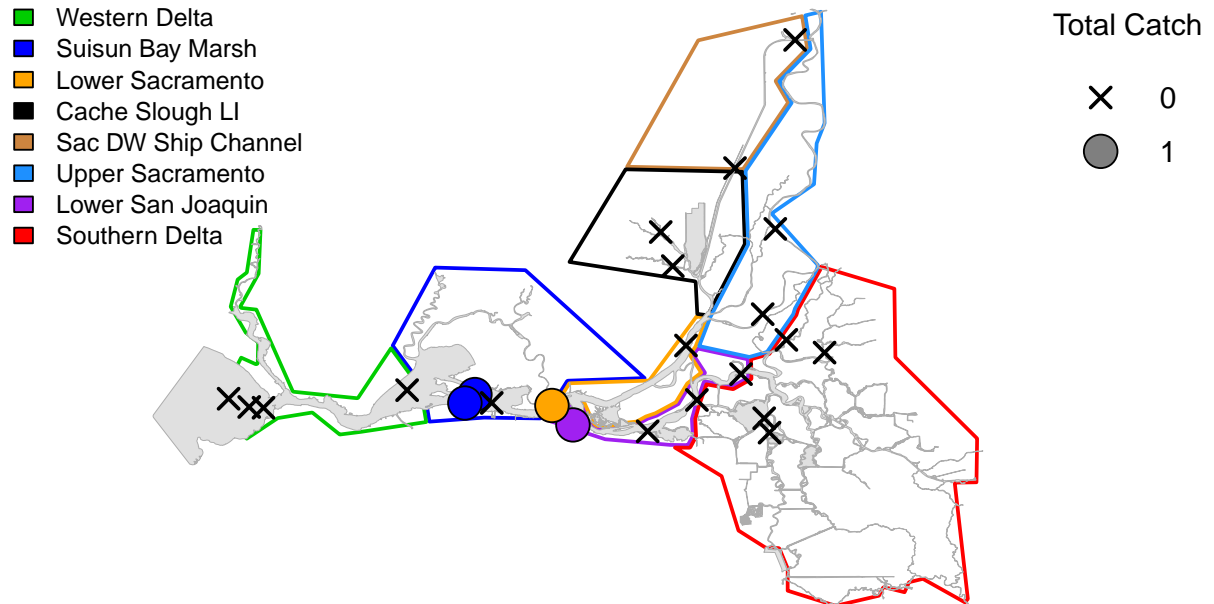


### Delta Smelt Catch Density by Site

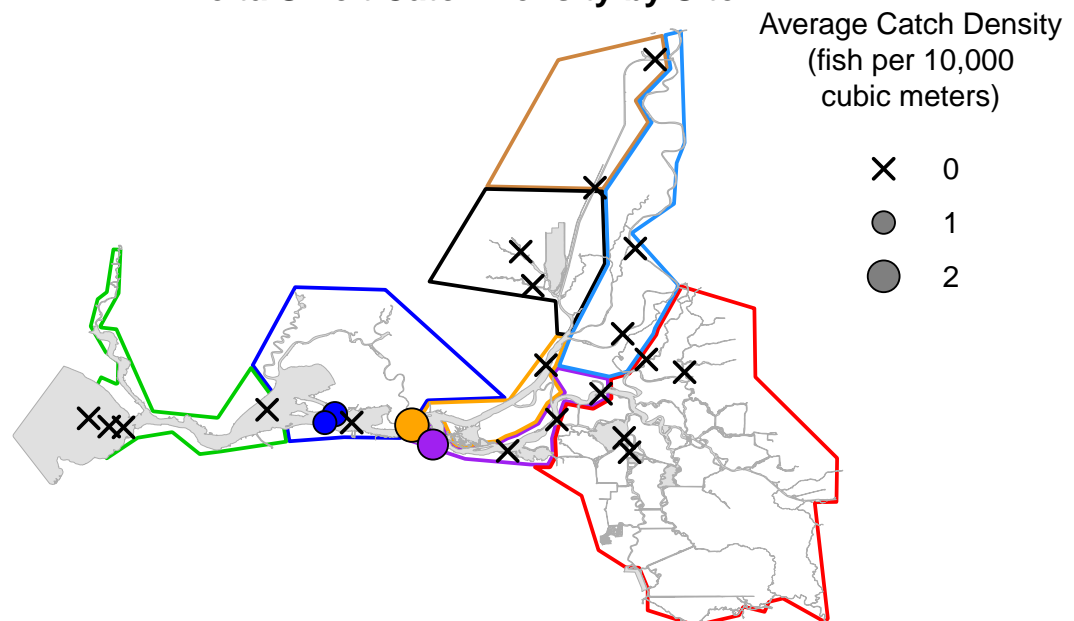


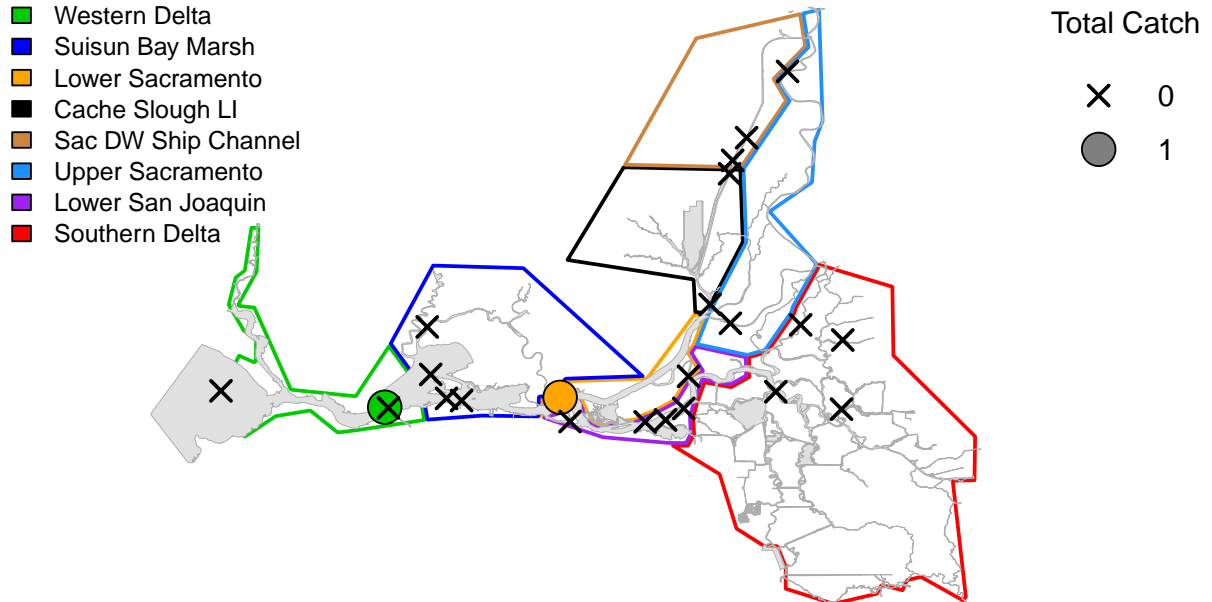
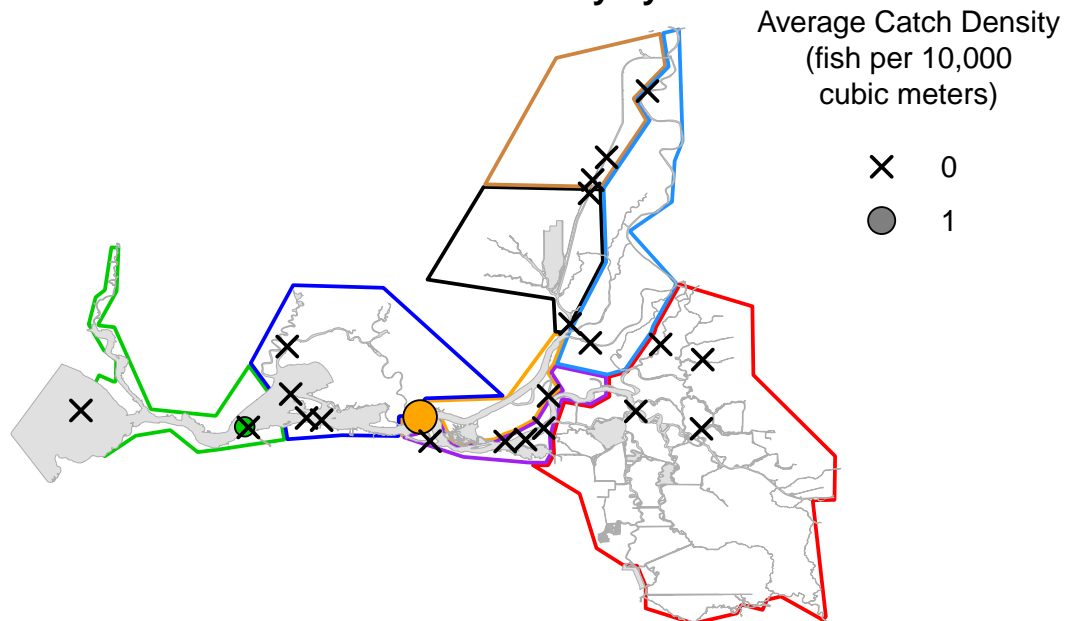
## Week 13 (Sep 25 – Sep 29, 2017)

### Delta Smelt Total Catch by Site

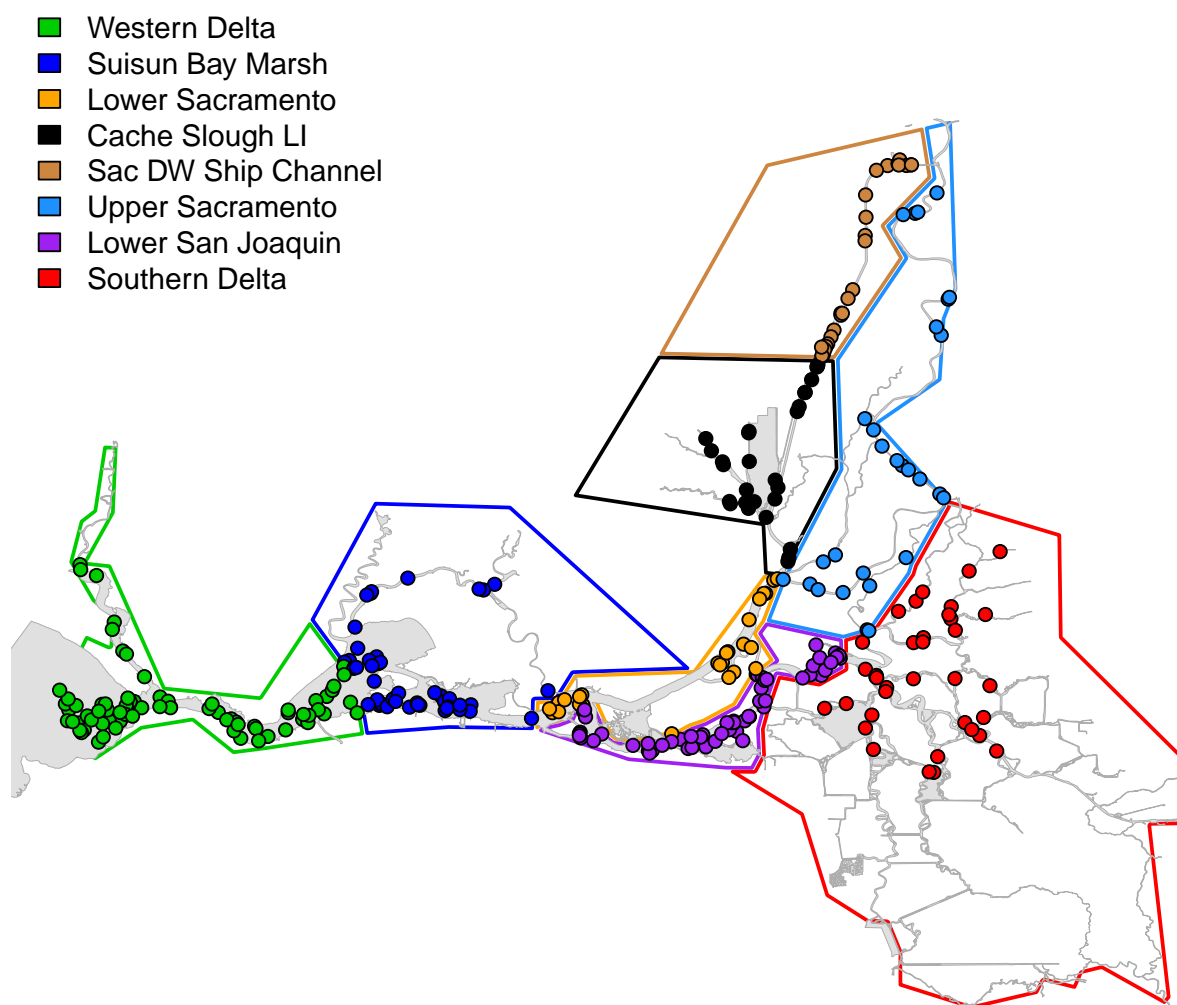


### Delta Smelt Catch Density by Site



**Week 14 (Oct 2 – Oct 5, 2017)****Delta Smelt Total Catch by Site****Delta Smelt Catch Density by Site**

## All Sampling Locations To Date



## References

- [1] Stevens, Don L., Olsen, Anthony R. 2004. Spatially balanced sampling of natural resources, *Journal of the American Statistical Association*, 99(465): 262 – 278.